Jan. 16, 1945. G. M. SKINNER 2,367,316

BLOWPIPE AND NOZZLE THEREFOR

Original Filed Feb. 27, 1937

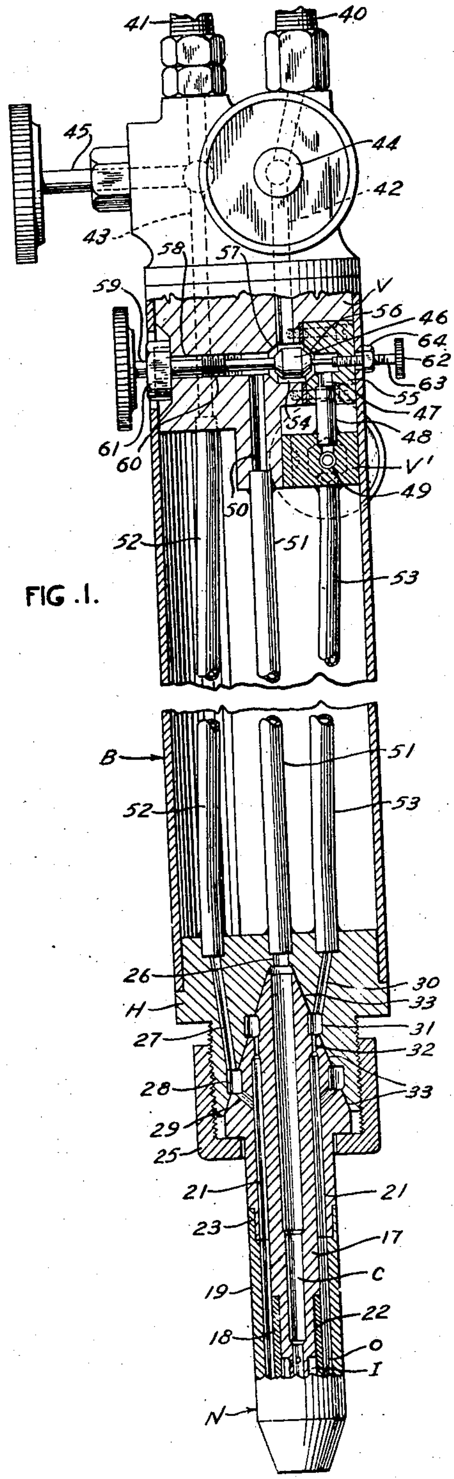


FIG. 1.

FIG. 2

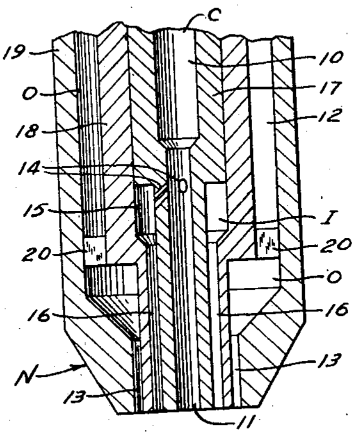


FIG. 3.

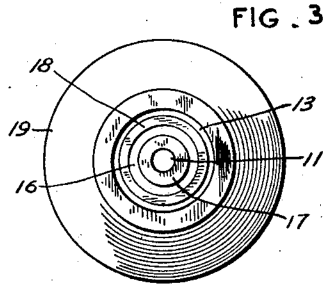


FIG. 5.

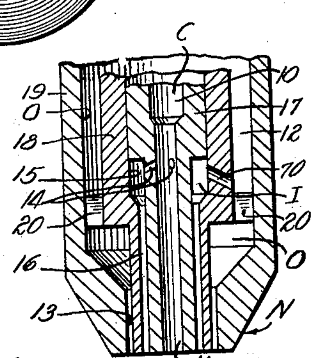
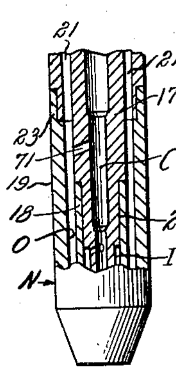


FIG. 4.



INVENTOR

GEORGE M. SKINNER

BY

E. L. Greenewald

ATTORNEY

Patented Jan. 16, 1945

2,367,316

UNITED STATES PATENT OFFICE

2,367,316

BLOWPIPE AND NOZZLE THEREFOR

George M. Skinner, Buffalo, N. Y., assignor to The Linde Air Products Company, a corporation of Ohio

Original application February 27, 1937, Serial No. 128,117. Divided and this application April 11, 1940, Serial No. 329,008

11 Claims. (Cl. 158—27.4)

This invention relates to blowpipes and nozzles therefor, and more particularly to blowpipes and nozzles useful in thermo-chemically removing metal from metallic bodies. This application is a division of my copending application Serial No. 128,117, filed February 27, 1937, now U. S. Patent No. 2,210,403.

It has been customary in such removal of metal from metallic bodies, particularly those composed of iron or steel, to heat a portion of the body to a sufficiently high temperature, usually designated as the "kindling" temperature, by means of a high temperature preheating flame, such as that produced by the combustion of a mixture of oxygen and acetylene; and then to direct a jet of an oxidizing gas, preferably pure oxygen, upon the portion previously heated to the kindling temperature so that the iron or steel upon which the oxidizing jet is directed will be partially converted to the oxide and swept away by the action of the jet. Both the combustible mixture jet which produces the heating flame and the metal removing jet of oxygen are normally discharged from the nozzle of a blowpipe. By a progressive movement of the blowpipe nozzle across the metallic body, a portion of the body may be removed and a cut produced along a line corresponding to the path of movement of the blowpipe. Such a method when utilized to sever a portion of the metallic body from the remainder of the body will produce a cut or kerf substantially corresponding in width to the oxidizing jet, which in this instance has usually a velocity of 600 to 1800 feet per second. In addition, such a method may be employed in thermo-chemically removing metal from the surface of a metallic body, and in such instances the velocity of the oxidizing cutting jet is usually lower than the velocity of the jet utilized in completely severing a portion of the body, being from 200 to 1000 feet per second.

However, since the upper edges of the kerf will not be maintained at the kindling temperature during cutting, due to the cooling action of the cutting jet, the lack of sufficient rapidity of heat conduction through the steel to the upper edges of the kerf, and the usual presence of millscale on the upper surface of the steel, it is necessary to supply heat to the metal undergoing treatment, in addition to the heat produced by the combustion of the iron or steel. To supply this additional heat, it has been customary to utilize the preheating flame used to heat a portion of the body to the kindling temperature. Such preheating flames have heretofore been produced by forming a combustible mixture of oxidizing gas and fuel gas, such as oxygen and acetylene, in a suitable mixer located in either the body or the nozzle of the blowpipe, and directing this mixture from the nozzle onto the portion of the body to be treated. Such preheating flames, which usually have a velocity of from 200 to 500 feet per second, have a high rate of combustion and a relatively high temperature; such flames are also relatively hard, since primary combustion of the oxy-acetylene mixture is completed a relatively short distance from the end of the nozzle.

A relatively high temperature and hard heating flame is unobjectionable when utilized to preheat a portion of a metallic body to the kindling temperature, but when utilized to provide supplemental heat during the removal of metal by the oxidizing jet, the resultant surface produced by the cutting operation tends to become rough and corrugated, and in the case of the complete severance of a portion of the metallic body, the walls of the kerf tend to become rough and corrugated, with pronounced drag lines, and the edges of the kerf tend to become rounded. The roughness of the walls and the rounded edges of the kerf are produced by a melting down of the edges due to the high temperature and the relative hardness of the preheating flames.

In addition, with such combustible mixture jets it is impossible entirely to eliminate flashbacks, with the attendant danger of spoiling expensive shape-cut parts when the work is partially finished.

In my copending application Serial No. 128,117, now U. S. Patent No. 2,210,403, and also in the copending application of John M. Gaines, Jr., Serial No. 128,083, filed February 27, 1937, now U. S. Patent No. 2,210,402, there is disclosed a method of overcoming this objection by utilizing a "diffusion" flame to provide supplemental heat during the removal of metal by the oxidizing jet. The diffusion flame is produced by directing, onto the metallic body, a low velocity jet of combustible gas adjacent the cutting jet, and a low velocity jet of oxidizing gas between the cutting jet and the combustible jet. The low velocity jets of combustible gas and oxidizing gas, which may have a velocity of 35 to 175 feet per second and preferably about 75 feet per second, intermingle outside the nozzle and burn with a soft gentle flame, particularly adjacent the surface of the body, and liberate the greatest amount of heat where the two jets come together at the lip or edge of the kerf. A diffusion flame, when utilized to provide supplemental heat during cutting, produces a kerf having a smooth wall and sharp upper edges. In addition, jets mixing and burning outside the nozzle entirely obviate the danger of backfires or flashbacks during the removal of metal by the cutting jet, thus eliminating the danger of spoiling expensive shape-cut parts when the work is partially finished.

A principal object of this invention is to provide suitable apparatus, such as a blowpipe, which is particularly useful in carrying out the above described method, wherein a diffusion flame is used to provide supplemental heat during the removal of metal from a metallic body by a jet of oxidizing gas or oxygen. Further objects of this invention are to provide such apparatus wherein the flow of oxidizing gas to the diffusion flame is properly regulated; to provide such apparatus which includes means for producing a combustible mixture for initial preheating, and a diffusion flame for supplemental heating during the removal of metal; and to provide such apparatus which is economical and efficient in operation. Other objects and novel features of this invention will become apparent from the following description and the accompanying drawing, in which:

Fig. 1 is a vertical view, partially in section, of a blowpipe constructed in accordance with this invention;

Fig. 2 is an enlarged vertical sectional view of the lower end of the nozzle of the blowpipe of Fig. 1;

Fig. 3 is an enlarged horizontal view, looking upwardly, of the end of the nozzle of the blowpipe of Fig. 1;

Fig. 4 is a vertical view, partly in section, of the lower end of a modified form of a nozzle adapted for attachment to the blowpipe of Fig. 1;

Fig. 5 is an enlarged vertical sectional view of another modified form of a nozzle also adapted for attachment to the blowpipe of Fig. 1.

As illustrated in Figs. 1 and 2, a nozzle N of a blowpipe may be provided with a central passage C through which a stream of oxidizing gas may be passed; an outer passage O through which a stream of combustible gas, such as acetylene, or a combustible mixture, such as a mixture of oxygen and acetylene, may be passed; and an intermediate passage I through which a stream of oxidizing gas, such as oxygen, may be passed. The central passage C may be provided with an upper portion **10** and a restricted lower portion or outlet **11** by means of which a jet of oxidizing gas having a relatively high velocity may be formed in a well known manner, the oxygen pressure in the upper portion **10** being considerably greater than the pressure in the lower portion **11**, and the drop in pressure when passing into the restricted portion giving the oxygen stream the desired velocity. The outer passage O may be similarly provided with an upper portion **12** and a lower restricted portion or outlet **13** which is adapted to direct a jet of combustible gas or a combustible mixture substantially parallel to the central jet and onto a portion of the metallic body adjacent that upon which the central jet impinges.

In accordance with this invention the supply of oxygen to the intermediate passage is derived from the oxygen passing through the central passage, such as by means of a plurality of connecting or inlet passages **14** which lead from the restricted portion **11** of the central passage into an enlarged portion or chamber **15** of the intermediate passage, from whence the diverted oxygen will flow through a lower restricted portion or outlet **16** of the intermediate passage. The chamber **15** not only distributes the gas equally around the periphery of the intermediate passage, but also reduces the velocity of the oxygen flowing therethrough, since the velocity of the oxygen passing through the lower portion of the central passage is considerably greater than that used in producing a diffusion type flame. The outlet **16** of the intermediate passage will direct a relatively low velocity jet of oxygen between the central cutting jet and the outer combustible gas jet. It will be apparent that due to this diversion from the central passage, oxygen will flow through the intermediate passage only when the cutting jet is employed, and the flow of oxygen through the intermediate passage will be regulated in accordance with flow through the central passage.

Also in accordance with this invention, the diameters or relative dimensions of the connecting passages **14** may be so proportioned that a definite predetermined amount of oxygen will be diverted from the central jet. In this way, the flow of oxygen through the intermediate passage may be controlled so that the optimum results will be produced when utilizing any given pressure in the upper portion of the central passage to produce a given velocity and rate of flow of oxygen through the lower portion. It will be apparent that in some instances, such as in a nozzle adapted to remove metal from the surface of a metallic body in which the central cutting jet has a lower velocity and the lower restricted portion **11** is eliminated or relatively larger in diameter, it may be desirable to divert oxygen into the intermediate passage from the portion **10** of the central passage; but it will also be apparent that in a nozzle adapted to utilize oxygen pressures of any considerable amount, the lower pressure existing in the restricted portion will permit the use of a greater number of connecting passages, which will tend to distribute the diverted oxygen more uniformly around the periphery of the enlarged portion **15** of the intermediate passage.

The central passage C may be formed in an inner or principal member **17** of the nozzle N; the intermediate passage I may be formed between the lower portion of the inner member **17** and an intermediate member **18**; and the lower portion of the outer passage O may be formed between the intermediate member **18** and an outer member **19**. The outer member **19** may be spaced from the intermediate member **18** by suitable means, such as lugs **20**, and, if desired, the intermediate member **18** may be similarly spaced from the inner member **17**. The upper end of the outer passage O may consist of a plurality of longitudinal passages or inlets **21**, drilled in the member **17**; and the members **18** and **19** may be secured to the inner or principal member **17** by suitable means, such as by press fits over the circumferential portions **22** and **23**, respectively. In addition, the outlets **13** and **16** of the outer and intermediate passages O and I, respectively, may be cylindrical, as is more clearly illustrated in Fig. 3, or may be formed as a plurality of small passages.

In order to supply oxygen and fuel gas to the various passages in the nozzle, the nozzle N, as in Fig. 1, may be secured to a head H of a body B of the blowpipe by a coupling nut **25** in such a manner that a central oxygen passage **26** formed in the head H is in alignment with the central passage C of the nozzle; and an outer passage 27 formed in the head H terminates in an annular groove in alignment with a similar groove formed in the nozzle N to form an annular chamber 28, from which connecting passages 29 lead to the inlets 21.

In order to provide a mixture of oxidizing gas and fuel gas in the outer passage O for use during initial preheating, an oxygen passage 30 formed in the head H may lead to an annular groove aligned with a similar groove formed in the nozzle N to form an annular chamber 31 from which a plurality of connecting passages 32 lead into the upper end of the inlets 21. In this manner a mixer is formed at the upper end of each of the inlets 21. By passing acetylene through the passage 27, the annular chamber 28, and the connecting passages 29, and simultaneously passing oxygen through the passage 30, the annular chamber 31 and the connecting passages 32, an oxy-acetylene mixture will be directed through the outer passage O of the nozzle, and will produce a high temperature heating flame, which when applied thereto, will quickly bring a desired portion of the metallic body to a temperature necessary for cutting or removal of a portion of the metallic body by means of a jet of oxygen directed from the central passage C.

The upper end of the nozzle may be conical in shape and a conical aperture formed in the head H, having the same slope as the upper end of the nozzle, so that when the nozzle is drawn tightly into the head by means of the nut 25, sealing surfaces 33 will be formed which will prevent leakage of gas from or to the central passage 26 and the annular chambers 28 and 31.

The body B of the blowpipe may be provided with an inlet connection 40, to which may be connected a line adapted to deliver a suitable supply of oxidizing gas, such as oxygen, and an inlet connection 41, to which may be attached a line providing a suitable supply of fuel gas, such as acetylene. Leading from the inlets 40 and 41, respectively, are passages 42 and 43, formed in a valve body V; and installed in the body V are shut-off valves 44 and 45, which are adapted to prevent the flow of gas through the passages 42 and 43, respectively, when the blowpipe is not in use. The valve 45 is also adapted to be used as a regulating valve for the fuel gas.

In further accordance with this invention, a two-way valve 46 is installed in the valve body V and utilizes the passage 42 as an inlet. Valve 46 is provided with two outlets—an outlet 47, to which is connected a tube 48 leading to a valve body V' in which is installed a regulating valve 49, and a second outlet 50. Tubes 51, 52, and 53, respectively, connect the outlet 50, the passage 43, and the outlet 47 (through the tube 48 and valve 49) with the central, outer, and intermediate passages 26, 27, and 30 of the head H. The valve 45 is adapted to regulate the flow of fuel gas through the tube 52 to the outer passage O of the nozzle, and the two-way valve 46 is adapted to permit the flow of oxidizing gas through the tube 51 to the central passage, or through the tube 53 to the outer passage O of the nozzle.

A valve chamber 54 for the two-way valve 46 is formed between a cap 55 and the valve body V, seats 56 and 57 being formed in the cap and the body V at either end of the chamber 54. When the two-way valve 46 is moved against the seat 56, oxygen will flow through the outlet 50, formed in the valve body V, to the central passage C of the nozzle; and when the two-way valve is moved against the seat 57, oxygen will flow through the outlet 47, formed in the cap 55, to the valve 49 and the outer passage O of the nozzle.

The valve body V is provided with a stem passage 58, through which a stem 59 of the valve 46 extends, the stem being provided with an enlarged threaded portion 60. The walls of the stem passage 59 are threaded to cooperate with the enlarged threaded portion 60 of the stem so that by turning the stem the valve 46 may be moved to any desired position between the seats 56 and 57. In addition, a gland 61 may be provided, the gland being threadedly secured to the body V and adapted to retain packing against the stem 59 to seal the stem during its movements.

To deliver a combustible mixture through the outer passage O of the nozzle N for preheating purposes, the two-way valve 46 is moved against the seat 57, and the flow of acetylene and oxygen to the outer passage O through the tubes 52 and 53 regulated by means of the valves 45 and 49, respectively. When the portion to be heated has reached the kindling temperature, the cutting oxygen is turned on by moving the valve 46 against the seat 56, the oxygen then passing through the tube 51 to the central passage C. During the removal of metal by the oxygen directed from the central passage C, supplemental heat will be provided by the diffusion flame produced by the acetylene directed from the outer passage O and the oxygen diverted from the central passage C into the intermediate passage I through the passages 14, as previously explained.

In case a slightly higher temperature of the supplemental heating flame is desired, such as in cutting at higher speeds or on rough surfaces, or in order to prevent the formation of carbon deposits in the lower ends of outlets 13 and 16, the valve 46 may be adjusted so that it is spaced a small distance from the seat 56 and a small amount of the cutting stream of oxygen is diverted at the valve 46 and flows through the tube 53 and into the outer passage O. However, in such instances, it is desirable to limit the amount of oxygen flowing through the tube 53 into the outer passage O so that an explosive mixture will not be produced in the outer passage. By careful adjustment of the valve 46 any desired proportion of oxygen in the stream of fuel gas issuing from the outer passage O may be easily obtained without changing the adjustment of the valve 49.

In case it is desirable to include a small predetermined amount of oxygen in the fuel gas during cutting, the correct setting of the two-way valve 46 during the cutting operation is first determined, and a stop screw 62, having a threaded portion 63 in engagement with a threaded hole in the valve body V and adapted to abut against the end of the two-way valve adjacent the seat 56, is turned into engagement with the end of the two-way valve and locked in position by a lock nut 64. The stop screw 62 may also be provided with a packing gland similar to the gland 61 provided for the stem 59 of the valve 46. In utilizing the stop screw 62, it is set in position during the first of a series of similar cutting operations. For subsequent cutting operations the two-way valve is merely seated against the seat 57, the preheat mixture adjusted by means of the valves 45 and 49; and when the portion to be cut has reached the desired temperature, the cutting oxygen turned on and the required predetermined amount of oxygen in the fuel gas in the outer passage automatically obtained by moving the two-way valve into abutment with the stop screw 62. During cutting, the required amount of oxygen to form the diffusion flame will be diverted from the cutting stream through the passages 14, as previously described.

An alternative method of supplying a small predetermined amount of oxygen to the fuel gas during cutting is by means of one or more metering passages, such as the passages of the nozzles illustrated in Figs. 4 and 5, which nozzles correspond to the nozzle of Figs. 1 and 2, except for passage 71 of Fig. 4 and passage 70 of Fig. 5. Passage 70 of Fig. 5 leads from the enlarged portion 15 of the intermediate passage I to the outer passage O. The passage 71 of Fig. 4 leads from the upper portion 10 of the central passage to the outer passage O. Alternatively, such a passage may lead from the outlet 11 of the central passage to the outer passage O. In the last instance, the intermediate member 18 may be shortened so that it will be necessary to drill such metering passage or passages only through the inner member 17. By diverting a small predetermined amount of oxygen from the central passage into the outer passage, use of the stop-screw 62 of the two-way valve is unnecessary, and the adjustment of the amount of oxygen diverted into the fuel gas stream during cutting is not left to the operator.

It will be apparent that a mixer may be installed in the body of the blowpipe instead of being formed in the upper end of the inlets 21; that other arrangements of valves may be used; and that other changes may be made which will not depart from the spirit and scope of this invention.

What is claimed is:

1. In a blowpipe for removing metal from a metal body by the application of a heating flame to the body and the application of a metal removing oxygen jet to a heated surface portion of the body, a nozzle having a cutting oxygen passage formed therein and having a restricted portion at the discharge end adapted to form a metal removing oxygen jet; a second passage formed within said nozzle adjacent said first-named passage, said second passage having an enlarged portion and a restricted portion; at least one relatively small passage formed in said nozzle and leading from the restricted portion of said first-named passage to the enlarged portion of said second passage; and means for forming a combustible gas jet the combustion of which is supported by the oxygen jet discharged from said second passage.

2. In a metal removing blowpipe, a nozzle having an oxidizing gas passage formed therein; a second passage formed in said nozzle adjacent said first-named passage; a third passage, for combustible gas, formed in said nozzle adjacent said second passage; at least one passage formed in said nozzle and leading from said first-named passage to said second passage; and at least one passage formed in said nozzle and leading from said first-named passage to said third passage to introduce oxidizing gas into the combustible gas in said third passage, the relationship between said second and third passages being such that the jets discharged therefrom tend to mingle outside said nozzle and produce a combustible mixture adapted to burn to form a heating flame.

3. In a metal removing blowpipe, a nozzle having an oxidizing gas passage formed therein and having a restricted portion at the discharge end; a second passage formed within said nozzle adjacent said first-named passage; a third passage, for combustible gas, formed within said nozzle sufficiently close to said second passage so that jets discharged from said second and third passages tend to intermingle; at least one relatively small passage formed in said nozzle and leading from said first-named passage to said second passage; and at least one relatively small passage leading from said second passage to said third passage to introduce oxidizing gas into the combustible gas in said third passage.

4. In a metal removing blowpipe, a nozzle having an oxidizing gas passage formed therein provided with a restricted portion at the discharge end; a second passage formed in said nozzle adjacent said first-named passage, said second passage having an enlarged portion and a restricted discharge portion; a third passage, for combustible gas, formed in said nozzle adjacent said second passage; at least one relatively small passage formed in said nozzle and leading from the restricted portion of said first-named passage to the enlarged portion of said second passage; and at least one relatively small passage leading from the enlarged portion of said second passage to said third passage to introduce oxidizing gas into the combustible gas in said third passage.

5. A blowpipe for removing metal from metallic bodies, said blowpipe having a passage provided with an outlet for discharging a cutting jet of oxidizing gas against a portion of a metal body; a second passage provided with an outlet normally for discharging a jet of combustible gas against said body adjacent said first-named jet; means for diverting a portion of the gas flowing through said oxidizing gas passage and conveying such diverted portion to a third passage having an outlet for discharging a jet of oxidizing gas to support the combustion of said combustible jet, said outlets being so arranged that the combustion-supporting jet is directed between said cutting jet and said combustible gas jet; and means for selectively supplying oxidizing gas to said first-named passage and/or said second passage.

6. A blowpipe for removing metal from a metallic body comprising means for mixing a stream of fuel gas and a stream of oxidizing gas to form a combustible mixture; means for directing such mixture as a heating jet onto a portion of said body to be cut so as to raise such portion to a predetermined kindling temperature; means for directing a second stream of oxidizing gas as a cutting jet onto said heated portion; means for discontinuing said first-named oxidizing gas stream; means for diverting a portion of said second oxidizing gas stream and directing such diverted portion into said fuel gas stream so as to form a combustible jet having a relatively large proportion of fuel gas and a relatively small proportion of oxidizing gas; and means for simultaneously diverting a second portion of said second oxidizing gas stream and forming a separate jet of oxidizing gas directed upon such portions being removed.

7. In a metal-removing blowpipe, a nozzle having an oxidizing gas passage formed therein, a second oxidizing gas passage formed in said nozzle adjacent said first-named passage, a third passage for combustible gas, formed in said nozzle adjacent said second passage, at least one relatively small passage formed in said nozzle and leading from said first-named passage to said second passage, and at least one relatively small

passage leading from said second oxidizing gas passage to said third passage to introduce oxidizing gas into the combustible gas in said third passage.

8. In a metal-removing blowpipe, a nozzle having an oxidizing gas passage formed therein, a second oxidizing gas passage formed in said nozzle adjacent said first-named passage, a third passage for combustible gas, formed in said nozzle adjacent said second passage, and relatively small passages formed in said nozzle, one small passage extending between said first-named oxidizing gas passage and said second oxidizing gas passage to supply the latter passage with oxidizing gas, and the other small passage extending between said first-named oxidizing gas passage and said third passage to introduce oxidizing gas into the combustible gas in said third passage.

9. A blowpipe including a nozzle, said nozzle having a first passage provided with an outlet for discharging a high velocity cutting stream of oxidizing gas, a second passage provided with an outlet normally for discharging a hard jet of premixed preheating gases adjacent said first-named passage, and a third passage for discharging a low velocity stream of oxidizing gas to be mixed externally with a stream of combustible gas to provide a soft supplemental heating flame, means for supplying combustible gas to said second passage, means for selectively supplying oxidizing gas to either said first-named passage or said second passage, said nozzle having passage means between the first and third passages for diverting a small portion of the oxidizing gas from said first-named oxidizing gas passage to the third passage to support combustion of the relatively large flow of combustible gas so as to provide automatically the soft supplemental heating flame after the flow of oxidizing gas to said second passage is reduced by the selective means and the hard preheating jet dispensed with.

10. A blowpipe for removing metal from metallic bodies comprising a nozzle having a first passage provided with an outlet for discharging a cutting stream of oxidizing gas against a metal body, a second passage provided with an outlet normally for discharging a jet of preheating combustible gas against the body adjacent said stream, means for selectively supplying oxidizing gas to either said first-named passage or said second passage, means for conducting a combustible gas to said second passage, said nozzle having a relatively small passage for diverting a small portion of the oxidizing gas from said first-named passage to mix with the combustible gas in the second passage so as to provide a soft heating flame after the flow of oxidizing gas to said second passage is discontinued by the selective means.

11. A blowpipe including a nozzle, said nozzle having a first passage provided with an outlet for discharging a cutting stream of oxidizing gas, a second passage provided with an outlet for discharging a jet of premixed preheating gases adjacent said cutting stream, and a third passage for discharging a stream of oxidizing gas to be mixed externally with a stream of combustible gas from said second passage to provide a heating flame adjacent said cutting stream, means for supplying combustible gas to said second passage, and means for selectively supplying oxidizing gas to either said first passage or said second passage, said nozzle having passage means between the first and third passages for diverting a portion of the oxidizing gas from said first passage to the third passage to support combustion of the combustible gas when the flow of oxidizing gas to said second passage is reduced by said selective means.

GEORGE M. SKINNER.